REMARKS

Claims 22, 25, 26, 28, 33, 36, 37, 39 have been amended to correct minor informalities. No claims have been canceled or added. Accordingly, claims 22-43 are now pending in this application.

35 USC § 102(e)

Claims 22-43 stand rejected under 35 USC § 102(e) as being anticipated by Kern et al., US Pat. No. 7043665 (hereafter "Kern"). Applicants respectfully traverse these rejections, and request reconsideration and withdrawal of the rejections for the following reasons.

Under Applicants' invention, a storage system includes a plurality of disk drives including first disks configuring a RAID group and at least one second disk not initially in the RAID group. Each of the first disks stores one of data or parity data. The second disk is able to be used as a spare disk for replacing one of the first disks in case of impending failure of one of the first disks. When one of the first disks starts to fail, this is detected because the error status matches a predetermined first criterion. When this occurs, the storage system starts to copy (mirror) data from the failing first disk to the second (spare) disk. However, if another one of the first disks shows a more severe risk of failure, the storage system stops the copying of data from the original first disk to the second disk, and instead starts to copy data from the other first disk to the second disk. This enables the storage system to copy data

from the disk most likely to fail to the second disk, and replace the disk most likely to fail in the RAID group with the second disk so that the RAID group is maintained and stoppage of the storage system can be avoided.

Kern, on the other hand, teaches a mirroring method in which volumes in a primary storage system are mirrored to a local secondary storage system and also mirrored to remote secondary storage systems (see, e.g., Kern col. 3, lines 4-25 and FIG. 1). A local site 2 includes two storage controllers 4a, 4b, each having attached storage systems 8a, 8b, and a remote site 20 includes two storage controllers 22a, 22b having attached storage systems 26a, 26b (Kern col. 4, lines 27-31 and lines 38-41). The storage systems 8a, 8b, 26a, 26b may comprise an array of storage devices, such as JBOD, RAID array, etc (Kern col. 4, lines 64-67). A monitoring program 34 initiates (according to a mirroring policy 36) mirroring between volume pairs on the local storage systems 8a and 8b, mirroring between the local storage system 8b and remote storage system 10a, and mirroring between remote storage systems 10a and 10b (Kern col. 5, line 65, through col. 6, line 4). Upon detecting a failure at the local primary storage controller, the local monitoring program changes the network resources so that host applications perform I/O with respect to the local secondary controller (Kern col. 9, line 64, through col. 10, line 5). If there is a failure of the entire local site 2, and a remote failover option is selected, then reconfiguration is performed so that an address at the host that is directed to the

primary storage system 8a is directed to one of remote storage systems 26a, 26b (Kern col. 11, lines 20-35).

Accordingly, Kern teaches a conventional mirroring arrangement for mirroring data between logical volumes in separate storage systems. The mirroring of Kern does not start when the error status of the one of the disks matches a predetermined first criterion, as required by Applicants' claims 22 and 33. Rather, the mirroring in Kern takes place continually under normal operations, and when a failure is detected at the primary storage controller, the device address information is reconfigured in the hosts so that I/O operations are redirected to a secondary storage controller (see, e.g., Kern col. 9, line 64, through col. 10, line 5). Applicants' invention, on the other hand, is directed to providing at least one additional disk within the same storage system able to act as a spare in the case of failure of another of the disks. When the error status of a first disk in a RAID group matches a predetermined criterion, mirroring of data from that disk to a second disk in the storage system is started.

The Office Action confuses "starting to mirror data" in Applicants' invention with failover in Kern. In Kern, data is mirrored from the primary volume to secondary volumes in other storage systems under normal operations. Upon detection of a failure at the local primary storage controller, Kern's local monitoring program reconfigures device address information at all attached hosts to point to the local secondary storage controller 304b (see, e.g., Kern col. 9, line 64, through col. 10,

line 5). Thus, Kern does not start to mirror data from a first disk to a second disk when an error status of the first disk matches a predetermined criterion, as required by Applicants' claims. Rather, in Kern, the host I/O operations are redirected to a second storage controller 304b when a failure is detected at the primary storage controller 304a. This is not the case under Applicants' invention, wherein the host may continue to perform I/O with the storage system even while data is being copied from the first disk to the second disk. Also in Kern, upon failover of I/O operations to the local secondary storage controller, the local monitoring system issues a command to the local secondary storage system to copy any updates received to the remote primary storage controller 322 (Kern col. 10, lines 22-34). However, this copying of updates is to a logical volume in a remote storage system, and not starting mirroring of data from a disk in which an error status was detected to a second disk in the same storage system, as required by the claims 22 and 33.

Thus, Applicants' independent claims 22 and 33 include the limitation of "a control section configured to hold an error status of each of the first disks, and to start to mirror data between one of the first disks and the at least one second disk when the error status of the one of the first disks matches a predetermined first criterion." The Office Action states that Kern teaches this limitation at col. 9, lines 29-49. However, this portion of Kern is referring to a failover technique in which mirroring of logical volumes takes place between separate storage systems under normal operations. Kern does not teach starting to mirror data from a first disk in a

storage system to a second disk in the same storage system when an error status is detected on the first disk, as set forth in Applicants' claims. Further, the mirroring of Kern, even if it were analogous, does not start when an error status of the first disk matches a predetermined criterion, as recited in claims 22 and 33. Rather, the mirroring of Kern ends when the error is detected at the primary storage controller 304a because I/O from the host is then sent directly to the secondary controller 304b, and so mirroring from the primary storage to the secondary storage no longer takes place.

Further, Applicants independent claims 22 and 33 include the limitation of "a plurality of disks including first disks configuring a RAID group and at least one second disk" The Office Action states that Kern teaches "at least one disk to be used as a spare disk" (citing Kern at col. 6, lines 4-11). However, this portion of Kern teaches separate storage systems 8a and 8b for providing mirrored logical volumes. Kern teaches nothing regarding a spare disk within one of the storage systems 8a or 8b. Rather, Kern teaches the use of logical volumes and mirroring of logical volumes from the primary storage system 8a to a local secondary storage system 8b or remote storage systems 26a, 26b. Also, Kern discusses that storage systems 8a, 8b, 26a, 26b may comprise an array of storage devices (col. 4, lines 64-67). Thus, Kern's storage devices are analogous to Applicants' disks, but Kern provides no discussion of disks (storage devices) that may be used as a spare disk. Kern's volumes, on the other hand, which are the subject of mirroring, are not analogous to

Applicants' disks since Kern provides no teaching of mirroring volumes within the same storage system, or starting mirroring according to an error status.

Additionally, the Office Action asserts that Kern teaches "wherein, after starting to mirror data between the one of the first disks and the at least one second disk, the control section is configured to stop mirroring data between the one of the first disks and the at least one second disk and start to mirror data between another one of the first disks and the at least one second disk, according to the error status of the one of the first disks and the another one of the first disks", citing col. 9, line 64, through col. 10, line 5, as further taught at col. 10, lines 22-34 and FIG. 9. However, these portions of Kern merely teach failover from a first logical volume to a secondary logical volume in a separate local storage system and continuation of mirroring to the remote storage systems. In particular, under Kern, when a local monitoring device detects a failure at the primary storage controller, device address information in control blocks of all attached hosts are reconfigured to point to the local secondary storage controller so that host applications perform I/O with respect to the local secondary storage controller (see, e.g., FIG. 9 of Kern). Contrarily, under Applicant's invention, the mirroring of the data from the one first disk to the second disk is stopped, and instead, the storage system starts mirroring data from another first disk drive in the storage system to the second disk drive, according to an error status of the first disk drives. It is respectfully submitted that the cited portions of Kern provide no disclosure or suggestion of this. It if further noted that both of these

first disks are clearly defined as being in the same RAID group in the same storage system (see line 1 of claims 22 and 33), and thus have no analogy with any of the volumes of Kern. Accordingly independent claims 22 and 33 are allowable.

Discussion of Dependent Claims

With respect to dependent claims 23 and 34, the Office Action cites col. 9, line 64, through col. 10, line 5, as teaching a control section that monitors the status of each of the first disks. However, this portion of Kern teaches a monitoring section 306 that detects a failure at the local primary storage controller 304a (col. 9, line 64-67). Thus, it is respectfully submitted that this portion of Kern provides no teaching regarding monitoring individual disks within a storage system. The Office Action notes that "*the monitoring program of Kern monitors the status of each drive at the local sites.*" However, after a complete and thorough review of Kern, Applicants have been unable to locate any teaching or suggestion of this aspect. Kern merely teaches detecting an error at the local primary storage controller 304a (col. 9, line 64-67). Kern provides no disclosure or suggestion of monitoring the error status of individual disks. As noted by the court in *In re Ahlert*, 424 F.2d 1088, 1091, 165 USPQ 418, 420 (CCPA 1970), the notice of facts beyond the record which may be taken by the examiner must be "capable of such instant and unquestionable demonstration as to defy dispute." Applicants respectfully submit that such is not the

case here. Accordingly, it is respectfully submitted that claims 23 and 34 are also allowable.

With respect to the rejections of dependent claims 24 and 35, the Office Action cites col. 10, lines 22-34, of Kern as teaching that "when the error status of one of the first disks matches a predetermined second criterion, the control section is further configured to stop mirroring between the one of the first disks and the at least one second disk and configure a RAID group including the at least one second disk instead of the one of the first disks." However, the cited portion of Kern merely teaches copying updates (i.e., data newly-received from the host) from the surviving local secondary storage to the remote primary storage controller. This portion of Kern does not teach configuring a RAID group within the storage system that includes the second disk upon the error status of one of the first disks matching a predetermined second criterion. Accordingly, it is respectfully submitted that claims 24 and 35 are also allowable.

With respect to the rejections of dependent claims 25 and 36, the Office Action further asserts that Kern teaches that the error status of each of the first disks is an error count of each of the first disks, and both of the predetermined first criterion and the predetermined second criterion are predetermined values of the error count. However, as pointed out above, Kern provides no disclosure or suggestion of error counts or using error counts for determining error criteria for

individual disks in a storage system. Accordingly, claims 25 and 36, are also allowable.

The remaining dependent claims set forth additional patentable features of the invention, and are also allowable over Kern and the other art of record.

Request for Interview

If, after reviewing the foregoing Remarks, the Examiner still feels that Kern teaches the claimed invention, Applicants respectfully request an in-person interview with the Examiner to enable a more productive discussion of the application of Kern to the pending claims. The Examiner is encouraged to contact Applicants' undersigned attorney to arrange an interview at the Examiner's convenience.

Conclusion

In view of the foregoing, Applicant respectfully requests that a timely Notice of Allowance be issued in this case.

Respectfully submitted,

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